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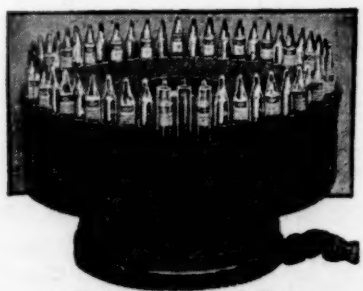

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COUNT RUMFORD—SCIENTIST AND PHILANTHROPIST[1]

BENJAMIN THOMPSON, the future Count Rumford, was born on March 26, 1753, in his grandfather's farmhouse, which still stands in North Woburn, Mass. When Benjamin was about a year and a half old his father died. A year or so afterward his mother married again, and the boy went to live with his stepfather. A small inheritance from his grandfather was used toward the support and education of the boy. He attended school in the village and also in Byfield and Medford. He was fond of mathematics and, like his forerunner, Isaac Newton, he was interested in practical things and was skilful in making mechanical devices. His opportunities as a schoolboy must have been well utilized because the handwriting, spelling and grammar of these early days, at least before the age of thirteen, are almost faultless.

Being too good, or too bad, for a farmer, he was apprenticed when thirteen years old to an importer in Salem. But he did not like clerking any better than farming. One authority says he was more interested in the mechanical appliances behind the counter than in the customers before it. And it is also said he even played the fiddle in the store when he was sure the sounds would not betray him. But he was not idle. A minister, noting his interests, taught him algebra, geometry, astronomy and even higher mathematics, so that before the age of fifteen he was able to calculate an eclipse accurately—"correct within four seconds," he says. At this time, too, he gave attractive evidence of his natural ability as a designer, draughtsman and engraver. His work in this field ranged from initials and devices on the handles of knives of his acquaintances to an elaborate bookplate for himself. Like most boys of his age, he was interested in chemistry and fascinated by spectacular experiments. On one occasion he came near losing his eyesight, if not his life, by the premature explosion of some chemicals he was grinding in a mortar for the preparation of fireworks "of extraordinary and unparalleled brilliancy" to celebrate the news of the repeal of the Stamp Act. Letters to his friend Loammi Baldwin show that even at this early age he was also interested in light, heat and color—phe-

[1] An address delivered March 26, 1928, at Woburn, Mass., on the 175th anniversary of the birth of Count Rumford.

nomena which subsequently occupied many years of his life.

In 1769 Benjamin Thompson was apprenticed to a dry goods dealer in Boston, but he remained only till the following spring, owing to decreased business arising from the non-importation agreement. A memorandum book made by him at this time reveals his tastes as a youth and foreshadows his interests as a man. Among the items are recipes for fireworks (especially "rockets, serpents and raining fire"), the sums paid for instruction in French, for pew rent, for lessons in fencing and for an electrical machine. Twenty pages contain sketches with pen or pencil. A few are crude, but most give definite evidence of accurate perspective and a skilful hand.

During 1770–1771 Benjamin Thompson boarded with Dr. John Hay, of Woburn, and while with him studied anatomy, chemistry, materia medica, etc. In the summer of 1771 he attended lectures on experimental physics given by Professor John Winthrop at Harvard College. Entries made during July and August, 1771, in an account book show that these were days of varied and hard labor, interspersed with periods of systematic study and experiment. Much time and energy were spent on the construction of the electrical machine. In passing we note that he paid 2s. 6d. for an ounce of nitric acid, 40s. for a pint of lacquer, and 5s. for an ounce of shellac.

In 1771–1772 he taught school in Wilmington and Bradford, and in the summer of 1772 he became master of a school in Concord, N. H., which was then called Rumford. At this time Benjamin Thompson, according to a contemporary record, was an attractive young man, having a fine, manly figure, handsome features, bright blue eyes and dark auburn hair. His manners were polished and his ways fascinating. He had used his opportunities to become cultured, and his knowledge of men and affairs was far beyond that of most of his associates.

His zeal, activity and engaging ways enabled him to give satisfaction as a teacher. But his career as a teacher soon ended, for toward the close of 1772 he married the daughter of the Reverend Timothy Walker, one of the prominent men of the town. He acquired thereby a large estate and ample means and entered upon a new life. His days were spent in developing the estate and sharing in the social and political events of the time. He also read diligently, especially books on science, invention and discovery.

Benjamin Thompson, like other young men of his time, especially men of aristocratic tastes and autocratic temperaments, became entangled in the political net that was spread over New England and was compelled to leave the land of his birth. And since we are considering the scientific and philanthropic work of Benjamin Thompson, let us pass over the domestic, political and military events of this part of his life.

Resuming our account, we find him in England in 1778 making experiments on gunpowder and firearms, a field in which he was deeply interested. These experiments were undertaken to determine the most advantageous position for the vent in firearms, to measure the velocity of bullets and to study the recoil of the gun under various conditions; also to determine the force of fired gunpowder. The account of these experiments covers about 175 pages in Volume I of the edition of Count Rumford's work published by the American Academy of Arts and Sciences. Subsequently he made experiments to determine the maximum pressure produced by the explosion of powder, and showed that the value of powder in ordnance does not depend solely on the total amount of gas produced, but on the rapidity of combustion as well. Some of these experiments were made on shipboard and the results were utilized in naval guns. It was at this time, too, that he devised a new code of marine signals.

These investigations attracted the attention of Sir Joseph Banks, president of the Royal Society. Mutual tastes and interests led to a friendship which lasted many years. In 1779 Benjamin Thompson was elected a Fellow of the Royal Society, "as a gentleman well versed in natural knowledge and many branches of polite learning." This recognition elated him and opened a pathway to association with scientists of renown—an opportunity utilized throughout the rest of his life. Not yet weaned from a thirst for military fame, Lieutenant Colonel Benjamin Thompson left England toward the end of 1783 to travel on the continent, and perhaps to serve in the Austrian army against the Turks. But the would-be warrior never fought again, though he served a vast army in peaceful ways. Two accidental experiences led to a sudden reversal of his intentions, indeed, his whole subsequent life was profoundly changed. One event we state in his own words. An excellent person, he says, "gave me the wisest advice, made my ideas take a new direction, and opened my eyes to other kinds of glory than that of victory in battle." The other event was a chance meeting with Prince Maximilian, then Field Marshal of France, and afterward Elector of Bavaria. Colonel Thompson attended a military review at Strasbourg attired in a resplendent uniform and mounted on a fine horse. The prince was attracted by the bearing of this foreign officer and gave him a letter of introduction to the Elector of Bavaria (uncle of the prince).

The Elector of Bavaria, Charles Theodore, immediately invited Benjamin Thompson to enter his

service in a semi-military and semi-civil capacity, and to assist in reorganizing his dominions and eliminating undesirable abuses. Before accepting this appointment, it was necessary for Benjamin Thompson, who was an officer in the British army, to obtain the permission of King George III. The king not only approved of the arrangement, but on February 23, 1784, conferred on him the honor of knighthood. The document permitting Sir Benjamin Thompson to display and use the arms of "the ancient and respectable family of Thompson of York" is now in the library of the American Academy of Arts and Sciences, Boston, Mass.

Sir Benjamin returned at once to Bavaria. To give him power and standing he was appointed colonel of a regiment of cavalry and made a general aide-de-camp. A palatial residence in Munich was provided for him, and here he lived in luxury. His days were spent in scientific and philanthropic work to which it would be difficult to find a parallel in all history. His aim was to discover scientific principles and apply them to the welfare of the people and the state, especially principles and applications involving economy and utility in living.

In 1788 he was made major-general of cavalry and privy councillor of state. At the same time he was made head of the war department and given instructions to carry out his plans for the reform of the army and the removal of mendicity.

The pay of the soldiers was a mere pittance per day, their living quarters were extremely uncomfortable and their drill and discipline were irksome. Sir Benjamin set to work to make "soldiers citizens and citizens soldiers." Their pay, uniform and quarters were improved; and the discipline was lightened. Schools were connected with all regiments, and here not only the soldiers, but their children were taught gratuitously. Moreover, the soldiers were employed in public works, thereby acquiring habits of industry, and their work was enlivened by music of their own military bands. They were also supplied with raw material of various kinds, and allowed, when off duty, to manufacture various articles and sell them for their own benefit. The garrisons were made more or less permanent, so that the greater part of a soldier's life was spent at home. Each soldier, too, was allotted a small garden for his own use, and its products were his sole property. Garden seeds, and especially seed potatoes, at that time not well known in Bavaria, were provided for the men. Under these circumstances a reform in the army was speedily effected and contentedly accepted.

Sir Benjamin's next work was with the mendicants. Munich itself was overrun with beggars. In many towns they were completely organized and stations of advantage were assigned in regular order or inherited according to established customs. In the country farm-laborers begged of travelers, and children were taught to beg from their infancy. The people had come to regard begging and its evils as inevitable. Sir Benjamin organized a regular system of military patrol throughout the villages, four regiments of cavalry being set apart for this work. Then on January 1, 1790, when the beggars were out in full force to keep their annual holiday, those in Munich were seized by the three regiments of infantry then in garrison. The beggars were taken to the town hall, and their names and addresses entered on lists prepared for the purpose. They were ordered to present themselves next day at the military workhouse, and a committee was appointed to inquire into the condition of each person. The inhabitants of Munich, relieved of a terrible evil, readily subscribed money for systematic relief, while the tradesmen contributed food and other requisites to the committee. In the military workhouse the former beggars made uniforms for the troops, besides a great deal of clothing to be sold in Bavaria and other countries. Sir Benjamin himself fitted up and superintended the kitchen where food was cooked daily for a thousand or more persons. Under his management, a nourishing dinner for a thousand could be cooked at a cost of about nine cents for fuel—a typical example of the useful applications of science and philanthropy advocated and applied by him.

During an interregnum the Elector of Bavaria became Vicar of the Holy Roman Empire, and he took advantage of his temporary power in making Sir Benjamin Thompson a Count of the Holy Roman Empire. The title which the new count selected was Rumford, the old name of the village in New England where he had spent the first years of his wedded life.

Count Rumford remained in Munich eleven years before returning to England. Let us consider some of the outstanding scientific accomplishments of this period.

One of his investigations was an elaborate series of unique experiments on the heat-conducting power of fluids. He showed among many other things that convection currents are the principal means by which heat is transferred through fluids, and described how, when a vessel of water is heated, there is generally an ascending current in the center, and a descending current all around the periphery. Hence he concluded it is only when a liquid expands by increase of temperature that a large mass can be readily heated from below. He also pointed out the exceptional behavior of water below 39° F., *viz.*, it contracts when heated and expands when cooled. Then he proceeded to explain how large bodies of water

are prevented from freezing at great depths on account of the expansion which takes place on cooling below 39° F., and he mentions as an example that in the Lake of Geneva, at a depth of a thousand feet, the temperature was found to be 40° F. He emphasized the fundamental bearing of this unusual behavior of water on climate everywhere, and on the preservation of trees, fruits and vegetables during the winter in cold countries.

In his experiments on the heat-conducting power of liquids, Count Rumford tried the effect of increasing the viscosity of water by the addition of starch and of impeding its movements by the introduction of eider-down. The results enabled him to explain the inequalities of temperature in a mass of thick soup or stewed apples—inequalities which had once caused him to burn his mouth! He writes sagely on this point: "Heat passes with much greater difficulty or much slower in stewed apples than in pure water." Applying the same principles to moving air, he turned his conclusions to practical account in making warm clothing, not only of woven fabrics but also of feathers and fur. These experiments were a remarkable contribution to our knowledge of the function of heat in human experiences, and their record in the edition cited above covers nearly 250 pages.

In another series of experiments devoted to the radiating power of different surfaces he showed how the power varied with the nature of the surface and illustrated the results by demonstrating the effect of a coating of lamp-black in increasing the radiating power of a body.

He also investigated the absorption of heat by different surfaces. His results led to the law that good radiators are good absorbers, and the recommendation that vessels in which water is to be heated should be blackened on the outside.. In speculating on the function of the coloring matter in the skin of the negro, he said:

> Were I called to inhabit a very hot country, nothing should prevent me from making the experiment of blackening my skin, or at least, of wearing a black shirt, in the shade, and especially at night, in order to find out if, by those means, I could contrive to make myself more comfortable.

Other investigations dealt with the use of steam as a vehicle of heat, new types of boilers and stoves for economizing fuel, the nutritive value of different foods, the calorimeter with which he determined the amount of heat generated by the combustion of various bodies, fireplaces and cooking utensils. He was particularly interested in the last two, and an entire volume of the edition of Count Rumford's works mentioned above is devoted to descriptions of fireplaces and cooking utensils.

In some of his experiments on light he used the military workhouse in Munich, where the beggars were housed. Before deciding on the best way to light it, he made experiments on the relative economy of different methods, and for this purpose designed his well-known shadow-photometer. By introducing colored glasses in front of the lights of the photometer he compared the illuminating powers of different sources with respect to light of a particular color. The complementary tints exhibited by the shadows led him to propose his theory of the harmony of complementary colors. Other experiments on light were devoted to light from luminous bodies, chemical properties attributed to light and the management of light in illumination. These experiments, like those on heat, were extensive, the part on management covering nearly 150 pages in Volume IV of the American Academy edition.

The experiments by which Count Rumford will be best known by future generations are those described in his essay entitled "An Inquiry concerning the Source of the Heat which is Excited by Friction." This essay, unlike most of the others, is short—only about twenty pages—but it is extremely important because it is a record of a wonderful discovery. While supervising the boring of cannon in the foundry he had built near the arsenal in Munich, he was amazed by the excessive amount of heat generated during the process of boring. He noted that chips of the metal shaved off were hotter than boiling water. And it occurred to him that further experiments might settle the age-long dispute as to "the existence or non-existence of an igneous fluid" called heat. The scientists of his day believed that heat was an imponderable fluid, called caloric, which flows from a body of higher temperature to one of lower, much as water flows from a higher to a lower level. They also believed that substances had different capacities for heat.

Now the French chemist Lavoisier had already established the fact of the conservation of matter, and Count Rumford reasoned thus:

If heat is a fluid, it can neither be created nor destroyed; consequently, either the same amount of heat must be present in the hot chips and cannon as in the unbored metal, or else heat must have reached the cannon from outside.

Having thus put the case clearly to himself, he proceeded to make experiments to determine whether or not heat is a fluid.

If no heat reached the cannon from outside, he argued, then the rise in temperature of the chips might be explained by the supposition that gun-metal in the form of chips has a smaller capacity for heat than metal in a block. When, however, he

compared by experiment the capacities for heat of gun-metal in these two forms, they were found to be the same. It had seemed to him, from the first, unlikely that the observed rise of temperature in the process of boring cannon could be accounted for in this way, yet to be doubly sure he repeated the boring experiment, using a very blunt tool, pressed with a force of ten thousand pounds against the bottom of a revolving cylinder which he had cut off from the casting of a cannon. In this case, only 837 grains (Troy weight) of metal were detached, while the temperature of the apparatus rose 70° F. (from 60° F. to 130° F.) in an hour.

In the experiment just described, the external air had free access to the inside of the cylinder, so, to ascertain whether air could have imparted heat to the apparatus, he excluded the air by means of a piston and repeated the experiment. The result was substantially the same. But it might be possible, he argued with keen insight, that some heat was generated in this second experiment by the friction of the piston in the bore of the cylinder, so the whole apparatus was enclosed in a box containing water, and the experiment was repeated. This time the result was even more striking than before, for after boring two and a half hours the water actually boiled!

"It would be difficult," wrote Count Rumford in his essay, "to describe the surprise and astonishment expressed in the countenances of the bystanders on seeing so large a quantity of cold water heated and actually made to boil without any fire."

He had shown by experiments that the heat produced was not furnished by the chips of metal, nor by the outside air, nor by the water surrounding the apparatus. He had also shown this positive fact, *viz.*, that as long as friction continued heat was given off: "Whence did it come?" he asked. His answer is given in the last paragraph of the paper he read before the Royal Society in January, 1798, *viz.*:

> It is hardly necessary to add, that anything which any insulated body, or system of bodies, can continue to furnish without limitation, can not possibly be a material substance; and it appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the Heat was excited and communicated in these experiments, except it be *motion*.

In 1795 Count Rumford returned to England to renew his friendships with scientists, read his papers, apply his philanthropic ideas and publish the essays describing his scientific investigations and philanthropic work done in Bavaria. His wife had died three years previously, but the daughter Sarah, now a young woman twenty-one years old, was still living in America. So he invited her to come to England. She remained with her father more than three years and her autobiography gives much information about his activities.

While in England at this time Count Rumford attracted considerable attention by his practical and useful experiments on chimneys, stoves, fireplaces, use of fuel, cooking utensils and the art of cooking economically on both a household and an institutional scale. Some of his experiments gave him a conspicuous notoriety, but he was as sincere as he was successful in eliminating expensive discomfort in homes and hospitals and in substituting therefor economical use of fuel and inexpensive preparation of nutritious food. Not all his work in this field was done in England. It was an extensive field and the experiments consumed much time, especially those concerned with fireplaces and food. Over five hundred pages in Volume III of the edition cited above are devoted to fires in fireplaces, etc. Much space is given to cooking utensils, including the famous "roaster," boilers, stewpans, covers, handles and materials of which such things should be made. Processes of cooking are described, and tables of results of cooking, nutritive qualities and comparative food values are scrupulously and precisely compiled. It was a monumental piece of work, carefully executed, admirably illustrated by over one hundred cuts and done with the sole purpose of helping rich and poor to live more comfortably, economically and happily. Count Rumford was the first man to advocate sensible home economics and rational dietetics.

During this visit to England Count Rumford presented $5,000 each to the Royal Society of Great Britain and the American Academy of Arts and Sciences of Boston for the purpose of endowing a medal, called the Rumford medal, to be given each alternate year for the best work done during the preceding two years on heat and light. He directed that two medals, one in gold and the other in silver, should be struck from the same die. Whenever no award was made, the interest was to be added to the principal, and the excess of the income for two years over $300 was to be presented in cash to the recipient of the medal.

The first award of the medal by the Royal Society was graciously made in 1802 to Count Rumford himself, "for his various Discoveries respecting Light and Heat." Many famous scientists have been given the Rumford medal by the Royal Society, among them being Davy, Faraday, Pasteur and Tyndall. Tyndall received the medal only a few years before he came to Woburn for the express purpose of visiting the birthplace of Count Rumford.

The letter announcing the gift to the American Academy is in the library of the academy, together with many other letters from and to Count Rumford. The first man to receive a gift of money from the interest on the Academy Fund was Robert Hare, of Philadelphia, for "his invention of the compound blowpipe and his improvements in galvanic apparatus."

In the following summer (1796) Count Rumford and his daughter went to Munich, where they stayed two years. The daughter was made a countess, and the father relinquished part of his pension for her, thereby providing her with an annual income of $1,000 for life. Toward the end of their stay in Munich, Count Rumford was appointed minister plenipotentiary from Bavaria to Great Britain. But when he reached London in September, 1798, he found much to his chagrin that having been born a British subject he could not be accepted as an envoy from a foreign state. The daughter soon afterward returned to America and the Count remained in London. Relieved of political and diplomatic responsibilities, he devoted his time and energy to scientific and philanthropic activities. His chief work was the founding of the Royal Institution.

Count Rumford's visit to England in 1795–1796 had brought him into intimate contact with the Royal Society. His association with this exclusively academic society suggested the need of a society which would establish helpful and practical relations between scientists and workingmen. He drew up an elaborate plan for the formation of an "institution for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching by courses of philosophical lectures and experiments the application of science to the common purposes of life." The "proposals," as the plan was called, gave a detailed plan of operation and management, including an elaborate exhibit of models.

A lecture-room and laboratory were to be fitted up with the necessary apparatus, and the most eminent expounders of science were to be engaged for the purpose of "teaching the application of science to the useful purposes of life."

The lectures were to include warming and ventilation, the preservation of food, agricultural chemistry, the chemistry of digestion, of tanning, of bleaching and dyeing, "and, in general, of all branches of manufacture." The institution was to be governed by nine managers, of whom three were to be elected each year by the proprietors; and there was also to be a committee of visitors, the members of which should not be the managers. The king became patron of the institution, and the first set of officers was nominated by his majesty. The charter of the Royal Institution, as it was aptly named, was sealed on January 13, 1800.

Count Rumford's elaborate plan for the Royal Institution was sincere. The conception was a perfect expression of himself. It combined science and philanthropy, its twofold purpose was to seek the truth and make it useful. But, like many institutions established on broad foundations to meet the specific needs of a period, it was not developed as the founder planned. The practical and the useful as seen by Count Rumford were soon overshadowed by the scientific. Stoves, kitchens and contemporary mechanical contrivances were gradually set aside and quietly forgotten. Models were replaced by men—in succession Davy, Faraday, Young, Tyndall, Rayleigh, Dewar, Bragg and many others. These men have carried out Count Rumford's aim, not his special plans, but his aim as a scientist and philanthropist—discovery of truth which helps mankind. Let me cite two discoveries made by one man—only two made by Faraday. Faraday in 1825 in the laboratory of the Royal Institution discovered the chemical compound called benzene (C_6H_6) which is the starting point of a vast number of organic compounds which are indispensable to the comfort, health, pleasure and happiness of mankind. A few years later Faraday discovered the scientific principle on which the dynamo operates. This discovery soon became of practical use and has developed into our stupendous, intricate system of applied electricity. These two discoveries alone justify the establishment of the Royal Institution. Faraday made them. Count Rumford made them possible.

The Royal Institution is still in existence and from its laboratories and lecture hall the truth flows forth —useful truth for many people.

Count Rumford's life in London after he had started the Royal Institution was not pleasant. In Bavaria he had been accustomed to carry out his projects like an emperor. In London emperors were not acceptable. He could not agree with his board of managers—individually or collectively. Perceiving that the actual scientific work was well placed in the hands of the chemist, Humphry Davy, whom he had chosen, and "ordering that all the resources of the institution should be at his [Davy's] service," Count Rumford left England in May, 1802, never to return.

After spending some time in Paris and in Munich, he married (in 1805) Madame Lavoisier, widow of the famous chemist. The union was not happy. The Count loved a garden and hated dinner parties. The Madame despised flowers and delighted in banquets. So, after a few years, Count Rumford retired to a small estate in Auteuil near Paris. Here he lived peacefully with his books, his flowers and his friends

until his death in 1814. His grave in Auteuil is marked by an elaborate stone, kept attractive by joint contributions of the American Academy of Arts and Sciences and Harvard University.

Among Count Rumford's bequests was a considerable sum of money to Harvard College, now amounting to over $60,000. The general purpose of the gift according to the will is "to teach the utility of the physical and mathematical sciences for the improvement of the useful arts, and for the extension of the industry, prosperity, happiness, and well being of society."

The Rumford professorship of the physical and mathematical sciences as applied to the useful arts was established in 1816. Noted men have filled this chair, one being Eben N. Horsford, an industrial chemist, whose work has had a fruitful influence on the practical development of science in the United States.

Count Rumford's work as a scientist and philanthropist is commemorated not only in medals, but also in portraits and monuments. Two paintings show him as a young man, another just beyond middle life, when he was sent as ambassador to England, and two others in his later years—one by Kellerhofen and one by Rembrandt-Peale, the latter painted a short time before Count Rumford's death in Paris. There are two monuments in Munich. In front of the National Museum in Maximilianstrasse stand four bronze figures, ten feet in height; one of these is Count Rumford. This statue was erected in 1867, at the king's private expense. And in the English Garden, which Count Rumford planned and laid out, is a monument erected by grateful citizens during his absence in England in 1796. And in Woburn, Mass., there is a replica of the Munich statue.

Making an aerial survey, so to speak, of Count Rumford's work as a scientist and philanthropist, one is astounded by its extent, variety and originality. One marvels, too, that so much of his work was practical and useful, though planned by a scientific investigator and pursued in most cases solely to discover facts. One wonders, also, how he found time and strength to perform and record such a vast number of experiments. In this address much of his work has been left untouched, but enough has been considered to demonstrate that Count Rumford was a wonderful man and undeniably deserves the high place given him among the world's most famous scientists and philanthropists.

LYMAN C. NEWELL

BOSTON UNIVERSITY

IMPROVEMENT IN MORTALITY RATES AND EXPECTATION OF LIFE IN THE UNITED STATES FROM 1890 TO 1920[1]

THE problem of race betterment is qualitative and quantitative. We shall deal only with some of its quantitative aspects. It is one thing to be alive and in full possession of those physical and mental faculties which come with freedom from disease and favorable inherited tendencies and quite another to be substandard in vitality and ability to think and act. But when we deal quantitatively with longevity we are obliged to depend upon data which tell us only that a man is alive or dead. This dichotomy is peculiar to the population and vital statistics gathered by our Census Bureau. We can take no account of the man who is half dead—we count him as living to the same extent as the most splendid physical specimen in our broad land—he is a unit either in the census or the death register.

From this mass of raw data every ten years we construct life tables. Census statistics may be regarded as the journal entries of our bookkeeping and the life tables as the periodic balances which we strike in the ledger of life. They tell us nothing about ourselves as individuals, but reveal many interesting and important things about us as we are in the aggregate. If men are going to live and die during the next two or three decades under the same essential conditions as during the last decade, life tables enable us to predict the rate of mortality, expectation of life and numerous other things for each year of age with remarkable precision. So certain is this forecast that one of the greatest activities of modern civilization, the insurance of lives, is based on life tables and generally regarded as the most stable financially among them all.

We shall take the figures from 1890 to 1920 furnished by the Census Bureau at their face value and draw from them the best conclusions we can, whether or not they agree with what we would like them to be. They are disappointing in some respects because they lead to the conviction that we are not strongly headed towards substantial improvement in longevity if we understand by this term that most men can reasonably expect in the near future to live to be eighty years of age or over. Our life tables show that in this country since 1890 the average length of life at birth has increased at the rate of about five months per year from forty-three years to fifty-five years, or more than twelve years in all. Nor is there as yet a

[1] Address given in Battle Creek on January 3, at the meeting of the Third Race Betterment Conference.

decided diminution in the strength of this tendency towards improvement. What, then, is the cause for apprehension? An analysis of the distribution of this gain will show the weak link in the chain and reveal some very disturbing factors.

Writers and lecturers—and through them reports in the press and magazines—have fixed attention too closely upon this steady increase of the expectation of life *at birth*. They have predicted for man an average span of life of one hundred years, and even one hundred and fifty years, at a time not far away. The oft-repeated statement that we have increased the expectation of life fifteen years in the last three decades followed by the prediction that we may expect to double this gain in another quarter century is absurd, if we take all the implications of our life tables at their face value. What stands in the way of this advance?

We are all accustomed to the idea that general death-rates can not be employed to compare the standard of health and mortality in two communities unless the age distribution is the same in those communities. The expectation of life at birth is the reciprocal of the general death-rate and if one is not a good measure the other can be no better. A little consideration will also show that the expectation of life at birth taken alone is not a good measure of longevity. The age distribution of this gain must be determined. If it is all or nearly all under age fifty it can not be inferred that those who are living at ages beyond fifty are any better off than before. If the rates of mortality beyond age fifty remain the same the expectation of life at this age will not be changed and we have only nursed more people up to the age of fifty to be leveled off by the grim reaper in the same ratio as before. These rates unchanged will kill off ten million people at the age of fifty and over in the same time and proportionate incidence as ten thousand people.

Mortality rates during the last thirty years at ages beyond fifty have not shown a satisfactory decrease. In fact, in some states, for example, Michigan, the rates at these older ages have actually increased since 1901. In the original registration states the gain in the expectation of life at these ages during the first twenty years of this century has been practically nil. In Massachusetts during the thirty-year period 1890–1920 the improvement in expectation of life at age fifty-two has been less than three months. At age seventy-two the result is negative and men and women at this age in 1920 may expect on the average to live half a year less than those at the same age in 1890. The situation is more hopeful in the large cities; New York, Boston and Chicago show an improvement between one and two years in the expectation of life at age fifty-two, and it is likely that a similar condition exists in the other large cities. Apart from this there is no such decided tendency for improvement at these older ages as is shown during the first twenty years of life.

Many able writers have studied the possibilities of improvement in longevity by setting up hypothetically attainable mortality rates with a view of ascertaining the increase in expectation of life at birth. The answer has usually been between sixty and sixty-five years, a possible gain of ten to fifteen years over present average conditions. Too often these results are so promising that the author or his interpreters assume that a further lowering of mortality rates would add another fifteen years to the average lifetime at birth. But there is a limit to these possible gains. Suppose that we go to the extreme and assume that all the agencies at work are so effective that infant mortality is entirely eradicated, even more, that there are no deaths during the first twenty-two years of life. Then *if the mortality rates beyond this age are not improved* the expectation of life at birth would simply be twenty-two years plus the expectation of life at age twenty-two. This would give for the original registration states, males of 1920, an expectation at birth of sixty-five years. If no deaths should occur before age fifty-two, the expectation at

TABLE A

EXPECTED YEARS OF LIFE IN SELECTED AGE INTERVALS

Expected years of life	Males			Females		
Original Registration States						
In age interval	In 1901 Years	In 1920 Years	Gain Years	In 1901 Years	In 1920 Years	Gain Years
Birth to age 22	17.46	18.92	1.46	18.01	19.42	1.41
Age 22 to age 52	26.38	27.13	0.75	26.65	27.13	0.48
Age 52 to age 72	15.42	15.77	0.35	15.88	16.13	0.25
Age 72 to death	8.11	8.17	0.06	8.64	8.66	0.02
New York City						
In age interval	Years	Years	Years	Years	Years	Years
Birth to age 22	16.36	18.33	2.47	17.01	19.34	2.33
Age 22 to age 52	24.99	26.81	1.82	25.97	27.08	1.11
Age 52 to age 72	13.58	14.68	1.10	14.44	15.41	0.97
Age 72 to death	7.09	7.67	0.58	7.61	8.26	0.65

birth would increase to seventy-two years. This gives us some idea of the supreme importance of improving the rates of mortality beyond age fifty-two. Those who have attained this age are up against a fearful handicap and their chief hope for relief must come from those investigators who will find a way to reduce the rates of mortality at the *older* ages. He is a hopeful prophet who will predict an average age of eighty, ninety or one hundred years for those who are born now, if the cold facts are faced. There is an absolute limiting value for this expectation at any age equal to the sum of the age and the expectation of life at that age. But unfortunately the value of the latter depends almost entirely on the rates of mortality at that age and higher ages.

We shall now turn our attention to a brief study of the incidence of gains in the expectation of life at different periods of life. For example, we may well ask what gain has been made since 1890 in the *average* number of years one may expect to live between birth and age twenty-two. The application of simple actuarial formulas to our life tables enables us to answer this question. In 1890 for Massachusetts males the expectation was 16.04 years, in 1920 it was 18.81 years; thus a gain of 2.77 years was made for this period of life. For the age interval between age twenty-two and age fifty-two the gain was 1.57 years, between age fifty-two and seventy-two it was 0.44 years, and from age seventy-two to age at death it was −0.40 years, in other words, a retrogression. The same type of gain is obtained from the life tables for Massachusetts females.

TABLE B

COMPLETE EXPECTATION OF LIFE AT SELECTED AGES
Original Registration States

At age	Years	Years	Years	Years	Years	Years
Birth	47.88	54.05	6.17	50.70	56.41	5.71
22	40.55	42.69	2.14	42.11	43.59	1.48
52	19.35	19.91	0.56	20.43	20.79	0.36
72	8.11	8.17	0.06	8.64	8.66	0.02

New York City

At age	Years	Years	Years	Years	Years	Years
Birth	40.65	51.61	10.96	44.86	54.83	9.97
22	34.90	40.10	5.20	38.15	42.07	3.92
52	16.01	17.86	1.85	17.51	19.24	1.73
72	7.09	7.67	0.58	7.61	8.26	0.65

Similar results are exhibited by other classes of the population. The notable thing in all of them is the marked decrease in gains in the periods beyond age fifty-two. The large cities, New York, Boston and Chicago, show much better gains in these older age intervals than the other classes of the population. The explanation of the gain raises an interesting question; perhaps a large measure of this gain in the cities may be accounted for through easier access to the best hospital and medical service.

What constructive measures, then, can we formulate to meet this outstanding problem? They must be far-reaching and involve much beyond what we are doing now. We must appeal to every effective agency to make a renewed effort at this point. Investigators in biology, genetics, eugenics and bio-chemistry may discover methods for prolonging life more potent than those of the physician. When we reach a limiting point in the elimination of disease, the only one which remains is what we may call "Old Age." Most of us believe that human longevity is inherited and this may give a promising lead. In recent years students of genetics have been very active in investigating those characters which can be strengthened through inheritance. There is a question as to whether the improvement of mortality rates through a recognition of inheritance of long life should not be the starting point after medicine and all the other effective means with which we are familiar have been pushed to the absolute limit. The statesman and sociologist, the scientist in many fields, the educator and the enlightened press will all be prominent coworkers in this broader line of attack. The increase in the span of life is now the outstanding unsolved problem of the human race. Its supreme importance to man from every point of view should command the effective support of individuals and governments through scientific foundations of the broadest scope and unlimited resources.

JAMES W. GLOVER

UNIVERSITY OF MICHIGAN

SCIENTIFIC EVENTS

THE DANISH OCEANOGRAPHIC EXPEDITION[1]

THE oceanographical cruise on which the *Dana* recently started will be the first round-the-world oceanographical expedition since the the return of H. M. S. *Challenger* from her famous voyage more than 50 years ago. The leader of the expedition is Dr. Johannes Schmidt, and the general direction of it is entrusted to a committee under the patronage of Prince Valdemar, with Professor C. H. Ostenfeld, a member of the board of directors of the Carlsberg Fund, as president, and Vice-Admiral C. Amdrup as vice-president. The *Dana,* fully equipped, is placed at the disposal of the expedition by the Danish government; all other expenses than those of its preliminary equipment will be borne by the Carlsberg Fund.

[1] From the London *Times.*

The *Dana* is a steam trawler of the Lord Mersey type, purchased by the Danish government from the admiralty after the war, a sister ship of the English research vessel *George Bligh* and the Scottish *Explorer,* and normally employed, like them, in investigations of sea fisheries in pursuance of the concerted program of research of the International Council for the Exploration of the Sea.

According to the provisional arrangements, the *Dana* will first visit Spain and Portugal, the Straits of Gibraltar and the western part of the Mediterranean, and will then sail *via* Madeira and the Azores to the West Indies, and thence through the Panama Canal into the Pacific, visiting Tahiti, the Fiji Islands, New Caledonia, New Zealand and East Australia. After a stay of two months in East Australian waters the expedition will proceed northwards in the early spring of 1929 to Japan and China, and thence to the Malay Archipelago, the Dutch East Indies and Siam and across the Indian Ocean from Java to Madagascar. From Madagascar the route will follow the east coast of Africa, and the expedition will return through the Red Sea and the Mediterranean probably in the spring of 1930.

The areas selected for most intensive examination are the Straits of Gibraltar, the Straits of Bab-el-Mandeb, the sea round New Caledonia and the most easterly part of the Mediterranean. The purpose of the expedition is general oceanography, physicochemical as well as biological. Special attention will be paid to ocean depths, for which purpose the ship is equipped with up-to-date echo-sounding apparatus, but every branch of oceanography is provided for, both in the technical apparatus of the ship and in the qualifications of her expert staff. Investigations of the fauna of the sea bottom will be limited, owing to the expenditure of time which they involve, to certain selected areas, notably the waters about New Caledonia.

The investigations as a whole will form a logical continuation of Dr. Schmidt's former expeditions in the Atlantic and the Mediterranean, and it is Dr. Schmidt's intention, without interfering with the general oceanographical program, to pay particular attention to the life histories of all the species of eel to be found in Indo-Pacific regions. The way has been prepared for these investigations by a preparatory voyage made by Dr. Schmidt two years ago, and by the examination in the Carlsberg Laboratory at Copenhagen of large collections of specimens procured from the Pacific and the Indian Ocean.

AN INTERNATIONAL FUEL CONFERENCE

PLANS for the Fuel Conference to be held in London from September 24 to October 6, 1928, under the auspices of the World Power Conference, and in which the United States will take part, were made public on July 19 by the executive secretary of the Federal Power Commission, O. C. Merrill, who is general chairman of the American committee of the World Power Conference.

According to Mr. Merrill, each national committee will be permitted to send two official delegates to the Fuel Conference, which will deal with fuels as a source of heat and power. Among the delegates of the American Committee, as announced by Mr. Merrill, are the following:

Dr. Gustav Egloff, petroleum technologist, Universal Oil Products Company, Chicago, Ill.

H. W. Brooks, consulting engineer, 316 Metropolitan Tower, No. 1 Madison Avenue, New York City. (Representing American Society of Mechanical Engineers and the International Railway Fuel Association.)

O. P. Hood, chief, technologic branch, U. S. Bureau of Mines, Washington, D. C. (Representing American Society of Mechanical Engineers.)

Martin Frisch, manager of Field Engineering, Combustion Engineering Corporation, New York City.

G. A. Orrok, consulting engineer, 130 East 15th Street, New York City. (Representing American Society of Mechanical Engineers.)

David B. Rushmore, formerly consulting engineer, General Electric Company, New York City.

O. C. Merrill, general chairman, American committee, World Power Conference.

The Fuel Conference, which is to be held at the Imperial Institute in London, was organized as a sectional meeting of the World Power Conference by the British national committee with the approval of the international executive council of the World Power Conference. The Earl of Balfour is honorary president of the conference and Sir Alfred M. Mond is president.

The technical program is divided into five classes—solid fuel, liquid fuel, gaseous fuel, fuel utilization and general aspects, and under these heads will be discussed the composition and classification of fuels, preparation of fuels, storage, handling and transmission of fuels and the utilization of fuels.

GIFTS FOR MEDICAL RESEARCH AT THE UNIVERSITY OF PENNSYLVANIA

IT was recently announced that the University of Pennsylvania has received from Edward B. Robinette, an alumnus and banker of Philadelphia, a proposal to establish a foundation that, according to the founder's plans, may eventually have a capital of at least $1,000,000 and that is to receive immediately $250,000 of that sum.

In carrying out this plan, the first $250,000, which is to be given at once by Mr. Robinette, will be used by

the foundation for the establishment of a clinic for the study, treatment and prevention of diseases of the heart and circulatory system. In particular it is the donor's desire that an agency for treatment of patients at the clinic should become operative at once and that the clinic staff should immediately direct its efforts toward the ultimate prevention of such diseases.

The sum of $250,000 more is to be added to the resources of the clinic as needed, and the donor has further informed the university that he hopes to present, in due time, at least $500,000 more to the foundation for the development of education in the liberal arts.

In his letter to the trustees setting forth the plan to establish the foundation, Mr. Robinette said in part:

> The provision as to the clinic for the study, treatment and prevention of diseases of the heart and circulatory system is made because I am convinced that through this means a very great contribution can be made to the betterment of human welfare. Therefore it is my desire that the clinic should devote special attention to the study and treatment of diseases of the heart and circulation whose cure and relief will mean so much to all. When some other disease or group of diseases displaces heart and circulatory diseases from the position of first importance, I wish the clinic to concentrate upon the study and treatment of such other disease or diseases.
>
> I do this so that the work of the clinic may never be restricted to a field of treatment and study in which there may no longer exist a predominating menace, and so that the clinic may always devote itself to the attack upon that disease which at the time is the greatest obstacle to the continued activity of people of middle age and beyond, and especially those who are the leaders of our national life.

The University of Pennsylvania has also received an anonymous gift of $100,000 to carry on a study of the leucaemias and lymphomata in the Henry Phipps Institute for the Study, Prevention and Cure of Tuberculosis, one of the medical departments of the university. The study will be made in the institute under the direction of Dr. Eugene L. Opie, director of the institute's laboratory and director of the department of pathology of the University of Pennsylvania's School of Medicine.

GRANTS FROM THE DANIEL GUGGENHEIM FUND FOR THE PROMOTION OF AERONAUTICS

AT a recent meeting in Port Washington, New York, the board of trustees of the Daniel Guggenheim fund for the promotion of aeronautics authorized an appropriation of $290,000 to the University of Washington for the purpose of constructing an Aeronautics building. The appropriation was made at the request of Dr. M. Lyle Spencer, president of the university, and was granted in view of the work already accomplished at the university in establishing an aeronautical engineering course and in recognition of its outstanding importance as an engineering institution in the Northwest. It was announced that the board of regents of the University of Washington would request the legislature of the state of Washington to provide funds for the proper equipment and instructional staff of the building.

The fund also authorized an appropriation of $15,000 for the Harvard University graduate school of business administration for the purpose of establishing a research fund over a period of three years for the study of the economic and industrial effects and possibilities of commercial aviation.

The Massachusetts Institute of Technology received $34,000 to organize a three-year course in meteorology in that institution "in view of the need for meteorological instruction to keep pace with the development of commercial aviation."

In addition several smaller appropriations covering a wide variety of objects have been made. These included $25,000 to finance the weather reporting services on the Los Angeles-San Francisco airway; $2,500 for research in the development of a sensitive altimeter on the acoustic principle in the laboratory of the Technical University of Delft, Holland; the financing of the services of the aerologist for the Byrd Antarctic expedition, and $500 to the college of engineering, New York University, to underwrite a course of aeronautical meteorology to be given at the university during the second half of the current school year.

It has also been announced that the fund will transfer its emphasis from assisting commercial aviation and stimulating public interest in its development to the consideration of the scientific problems involved in the mechanical structure of the airplane and the study of environmental conditions necessary for safe operation, particularly meteorology and the problem of fog-flying.

SCIENTIFIC NOTES AND NEWS

AT the recent meeting of the International Astronomical Union held in Leyden, Holland, Sir Frank Dyson, British Astronomer Royal, was elected president for the next meeting, which it was decided to hold in the United States in September, 1932. This date was chosen in order that visiting astronomers might be in the United States at the time of the total eclipse of the sun, which will be visible in New England and eastern Canada on the afternoon of August 31, 1932.

THE Harbon gold medal of the Royal Institute of Public Health for 1928 was presented on June 28 to Sir Ronald Ross, in recognition of his eminent services to the public health.

MADAME CURIE, of Paris, was awarded the honorary degree of doctor of laws by the University of Glasgow on June 20.

DR. J. W. MCBAIN, Leverhulme professor of physical chemistry at the University of Bristol, received the honorary degree of doctor of science from the university on July 5.

BARON FERENCZ VON NOPCSA, of Vienna, and Professor Frederico Sacco, the well-known paleontologist of Turin, have been elected foreign members of the Geological Society of London. Dr. W. J. Jongmans, of Heerlen (Holland), and Señor Don César Rubio y Muñoz, of Madrid, have been elected foreign correspondents of the society.

AT a meeting of the Imperial Academy of Japan on April 14, the prize in commemoration of the emperor's wedding was awarded to Professor Dr. H. Kondo, professor in the pharmaceutical department of the Tokyo Imperial University.

DR. JAMES HAWKINS, associate chemist at the Hospital of the Rockefeller Institute, New York City, has been awarded the degree of doctor of science from the University of Edinburgh, Scotland. Dr. Hawkins received the degree of Ph.D. in physical chemistry from the University of Edinburgh in 1922, and since then has been connected with the Rockefeller Institute.

DR. HUGH H. YOUNG, of the Johns Hopkins University, will be awarded a fellowship by the Royal College of Surgeons of Ireland the first week in August. Dr. Young sailed for Europe June 20.

DE PAUL UNIVERSITY, Chicago, conferred the honorary doctor of science degree upon John Giesen, director of the department of biology in Holy Cross College, at its regular commencement exercises in June.

DR. W. R. WHITNEY, director of the research laboratory of the General Electric Company for the past twenty-eight years, has been elected a vice-president of the company.

DR. PORTER J. CRAWFORD has been appointed a member of the international health division of the Rockefeller Foundation. He will be stationed in Brazil for the next three years.

PERKINS COVILLE, professor of forestry at the Iowa State College, has been appointed associate silviculturist in the office of forest experiment station of the U. S. Forest Service.

DR. JAMES G. NEEDHAM, professor of entomology at Cornell University, has returned from spending a year in China with the China Foundation for the Promotion of Education and Culture. He lectured on biological subjects before Chinese universities in and around Peking, Tientsin, Tsinan, Shanghai, Hangchow, Soochow and Nanking. He has been made an honorary member of the Entomological Society of China and of the Chinese honorary scholastic society of Phi Tau Phi and a corresponding member of the Peking Natural History Society. He gathered large collections of dragonflies and is preparing a monograph of the Chinese Odonata.

DR. GEORGE B. CRESSEY, assistant professor of geology in Shanghai College, has left Peking for western Inner Mongolia to continue his geological work in the Ordos and Alashan deserts. The expedition will explore areas which are unknown geographically as well as geologically. It is hoped to secure material bearing upon the climatic conditions of central Asia during the time of man's evolution.

DR. JOSEPH W. PRYOR, head of the department of anatomy and physiology at the University of Kentucky, recently returned from a six months' trip to Europe. While there he gave lectures on osteology before the British Association of Anatomists and at the Paris School of Medicine.

DR. EDWARD L. STEVENSON, editor of the Hispanic Society of America, recently gave a series of four lectures on "The Expansion of Geographic Knowledge in the Renaissance, as Illustrated by Contemporary Maps," under the auspices of the department of geography of King's College, London. After having spent more than a year in research in the European libraries, Dr. Stevenson expects to return to the United States soon.

DR. DWIGHT E. MINNICH, of the department of zoology at the University of Minnesota, secretary of the American Society of Zoologists, who was recently awarded a Guggenheim fellowship for the coming year, sailed on July 26 for Europe, where he plans to continue his research studies on the physiology of the chemical senses of animals with particular reference to insects. This work will be carried on in various European laboratories, chiefly at the zoological institute of the University of Munich. Until October 1, 1929, all communications to the American Society of Zoologists should be addressed to Dr. L. B. Arey, acting secretary, Northwestern Medical School.

DR. GEORGE SAUTÉ, of Harvard University, has been awarded one of the fellowships of the commission for relief in Belgium Educational Foundation, for the study of mathematics in Belgium.

DR. TRUMAN MICHELSON, ethnologist, of the Bureau of American Ethnology, left Washington on July 6 to continue his researches among the Algonquian tribes of Oklahoma and Iowa.

WILLIAM R. MAXON, associate curator of the division of plants, in the National Museum, left for Europe on July 4, to study the fern collections of several of the larger European herbaria. Mr. Maxon's principal investigations will be carried on at the British Museum and at the Royal Botanic Gardens, Kew, in connection with the preparation of the fern volume of the Flora of Jamaica, a work now in course of publication by the British Museum. From England Mr. Maxon expects to go to Stockholm, Copenhagen, Berlin and Paris, and will return to Washington in October.

ACCORDING to the Japanese correspondent of the *Journal* of the American Medical Association the invitations to the International Conference of the League of Nations concerning the standardization of arsphenamines, in Frankfurt, and to the International Serum Conference, in Copenhagen, have been accepted by Dr. S. Hata, director of the Kitasato Institute, and by Dr. M. Nagayo, director of the government institute for infectious diseases. Their farewell dinner party was given in Tokyo, May 12, and was attended by more than seventy distinguished scholars and men of their profession.

PROFESSOR HANS DRIESCH, of Leipzig, Clifford lecturer in the University of Aberdeen for 1907–1908, has sailed for South America where he is to be international guest-lecturer at a number of national universities. Last summer Professor Edward J. Menge, of Marquette University, was the recipient of this lectureship.

THE following represented Canada at the meeting of the International Astronomical Union at Leyden: Professor D. Buchanan, Professor C. A. Chant, Professor A. S. Eve, Dr. F. C. Henroteau, Professor L. V. King, Professor A. H. S. Gillson, Dr. J. S. Plaskett.

A SCHOLARSHIP has been established at Oberlin College in memory of the late Dr. Frank F. Jewett, who was head of the department of chemistry, through a gift of $1,000 by Mrs. Jewett.

DR. JOHN WARREN, associate professor of anatomy in the Harvard Medical School, died on July 17.

SIR JOHN ISAAC THORNYCROFT, F.R.S., a pioneer in the design and construction of small high-speed vessels, died on June 28, aged eighty-five years.

SINCE its organization following the Washington meeting, the committee of one hundred on scientific research of the American Association for the Advancement of Science has suffered the loss by death of six of its members: Charles W. Eliot, president emeritus of Harvard University; James F. Kemp, professor of geology in Columbia University; Ira Remsen, president emeritus of the Johns Hopkins University; Theodore W. Richards, director of the Gibbs memorial laboratory, Harvard University; Edgar F. Smith, president emeritus of the University of Pennsylvania; Erwin F. Smith, plant pathologist, Bureau of Plant Industry, U. S. Department of Agriculture. At its meeting on June 14 in Washington, D. C., the executive committee elected the following to fill the vacancies: Frank P. Graves, president of the University of the State of New York; Bailey Willis, professor emeritus of geology in Leland Stanford University; E. W. Washburn, U. S. Bureau of Standards, Washington, D. C.; John Johnston, professor of chemistry in Yale University; Moses Gomberg, professor of organic chemistry in the University of Michigan; Edward W. Berry, professor of paleontology in the Johns Hopkins University.

THE fourth meeting of the National Plant Board was concluded in Washington, D. C., on Tuesday, June 26, with a joint conference with the Federal Horticultural Board at which national and state plant quarantine policies were discussed. The National Plant Board is made up of two members from each of the four regional plant boards—the eastern, the western, the central and the southern. The purpose of the National Plant Board is to assist in bringing about uniformity in the promulgation and enforcement of plant quarantines and to maintain contact between the federal and state authorities, especially between the Federal Horticultural Board and the regional plant boards. The members of the National Plant Board are: Lee A. Strong, California, *chairman;* Dr. Wilmon Newell, Florida, *vice-chairman;* R. E. McDonald, Texas; W. A. McCubbin, Pennsylvania; Professor George A. Dean, Kansas; M. L. Dean, Idaho; Professor A. G. Ruggles, Minnesota, and Professor W. C. O'Kane, New Hampshire.

THE seventh annual meeting of the National Conference on Pharmaceutical Research will be held at Eastland Hotel, Portland, Maine, on August 18. There will be two sessions of the conference, one beginning in the morning and the other in the afternoon.

THE *Electrical Review* states that the council of the British Institute of Metals has accepted an invitation from the Verein deutsche Ingenieure and the Deutsche Gesellschaft für Metallkunde to hold next year's autumn meeting of the Institute at Düsseldorf. The meeting is expected to prove attractive not only

to British members, but also to members resident in Continental countries, who number many hundreds.

CHAS. N. GOULD, director of the Oklahoma Geological Survey, will serve during the ensuing year as director of research project No. 25A of the American Petroleum Institute, this work having to do with the determination of deep well temperatures in the State of Oklahoma. This is part of the work on geothermal gradients under the general supervision of Dr. C. E. Van Orstrand, of the U. S. Geological Survey, and under the general direction of the petroleum committee of the National Research Council, consisting of K. C. Heald, David White and E. DeGolyer. This work is going forward in the three states of California, Texas and Oklahoma. In the latter state, Mr. John A. McCutchin has been designated as observer and is now conducting experiments in the Healdton oil field in southern Oklahoma.

THE Chicago Academy of Science has undertaken to make a moving picture record of the wild life of North America. Thousands of specimens will be photographed and the entire continent represented. Local subjects will be filmed first, with the field of operations gradually broadened until the entire area is included. State and Federal authorities as well as private individuals interested in natural history are expected to aid in the work, which will proceed as rapidly as funds are available.

THE United States Navy Department's recent contributions to nautical science and to the advancement of safety at sea will be exhibited at the international exposition at Seville, Spain, opening next March. Prominent in the exhibit of the department will be the new charts of the coast of Cuba and the Gulf of Venezuela. The Naval Observatory will show types of navigational instruments used by ships and aircraft, including devices that helped Commander Byrd on the North Pole flight. The observatory will also demonstrate how the correct time is transmitted to ships at sea and to observatories in other countries.

THE Danish Naval Department has ordered several Heinkel hydro-monoplanes for the purpose of geographical survey and mapping in West Greenland for the Danish Geodetic Institute next year. It is the plan to send them to the Godhavn colony early in 1929.

THE University of Porto Rico has received, from an anonymous donor, a pledge of $25,000 toward the erection of a modern teaching museum, on condition that an additional $50,000 be secured from other sources. Tentative plans have already been drawn up for the erection of such a museum on the university campus and a campaign started for the purpose of securing the required funds.

A JOINT resolution recently approved by President Coolidge authorizes the Secretary of Agriculture to accept from James B. Munn, of New York City, on behalf of the United States, a gift of certain lands in Clayton County, Iowa, to become a part of the Upper Mississippi River Wild Life and Fish Refuge. These lands, embracing a total area of 488 acres estimated to be worth from $30,000 to $40,000, were donated to the government by Mr. Munn through his interest in the objects of the refuge.

THE offer of Dr. Samuel McCullagh to present to the academy of medicine a medal and sufficient funds to endow it has been accepted by the council. It will be known as "The Medal of the New York Academy of Medicine" and will be awarded for unusual contributions to medical science. A committee has been appointed to work out the details of the method of award.

THE conditions for the award of the Grasselli medal have been changed so that it may be awarded annually for the thesis offering the most useful suggestions in applied chemistry presented at a meeting of the American section of the Society of Chemical Industry or any joint meeting of that section with another scientific society. The medal committee is privileged to take under consideration the papers presented during a period of five years preceding the date of the award.

THE corporation of the Boston Medical Library has voted to have a campaign for funds to meet the necessity of providing space for its collection of books and expanding activities and to provide headquarters for the Massachusetts Medical Society and other appropriate professional associations. The library, three years ago, celebrated its fiftieth birthday and is today the fourth medical library in size and importance in the United States.

THIS year's Nobel prize winners will receive a sum of about £8,700 each, according to a report recently published by the Nobel Foundation in Stockholm. The total capital of the foundation is about £2,333,333, whereof about £1,750,000 constitutes the main fund. The gross receipts, consisting of interests and proceeds from investments of various kinds, amount to about £100,000, from which taxes (about £17,000) and general expenses have to be deducted, the sum available for prizes being about £43,600. The special funds of the Nobel Foundation now amount to about £150,000, a certain percentage of which is spent on the Nobel Library of foreign modern literature and on preparatory scientific research work in physics, chemistry and medicine. The prizes to be awarded this year are for physics, chemistry, medicine and literature.

UNIVERSITY AND EDUCATIONAL NOTES

JOHN D. ROCKEFELLER, JR., has given $2,000,000 to the University of Paris for the construction and development of a central building in the new students' quarter.

A GIFT of $1,500,000 has been made by Arthur J. and Leonard D. Baldwin, of East Orange, N. J., to the Drew Theological Seminary. The institution now becomes Drew University, and a college of liberal arts will be opened this fall.

THE chairman of the University College centenary fund has announced a conditional offer to advance zoological teaching and research in the University of London. The offer is to provide the sum of £120,000 under the condition that a further sum of £120,000 be raised so that not only the site, buildings and equipment, but the endowment necessary for staff and upkeep shall be secured, and that the scheme shall include chairs of genetics and comparative physiology and the teaching of other recent developments of zoological science.

DR. R. G. WALLACE, of Manitoba University, provincial commissioner of mines, has been appointed to the presidency of the University of Alberta, in succession to Dr. H. M. Tory, who is now head of the National Research Council.

DR. HOMER W. SMITH, professor of physiology at the University of Virginia, has been appointed head of the department of physiology in the medical school of New York University. In the department of biology of Washington Square College, Dr. Henry J. Fry, Dr. Ruth B. Howland and Dr. Charles R. Plunkett have been promoted to associate professorships. Dr. Douglas A. Marsland has been promoted to assistant professor and administrative secretary of the department.

THE following changes have been made in the chemical faculty at the University of Mississippi: Dr. H. H. Johnstone has resigned to enter upon a research problem in the University of Illinois. His place is to be taken by Dr. John E. Foglesong, of Trinity College, Conn. J. A. Riddick, who is completing his work for the doctor's degree at the Iowa State University this summer, is to join the faculty as an additional member.

AT the University of Missouri the following promotions have been made: Dr. Edward A. McCordock, from assistant professor to associate professor of pathology; Dr. Ethel Ronzoni, instructor to assistant professor of biological chemistry, and Dr. Arthur S. Gilson, Jr., instructor to assistant professor of physiology.

DR. GORDON H. SCOTT, of the Rockefeller Institute for Medical Research, and Dr. James L. O'Leary, of the department of anatomy of the University of Chicago, have been appointed assistant professors of cytology in the department of anatomy of the Washington University School of Medicine.

DISCUSSION AND CORRESPONDENCE

FORA TO BE HELD AS PART OF THE PROGRAM OF THE FOURTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

Two of the sessions of the section of taxonomy, distribution and nomenclature will consist of general discussions of problems of wide interest to taxonomists. In order that those who will attend may be thinking along these lines and thus be prepared to take part, it seems desirable to publish the following list of topics to be discussed.

Sessions of the section will also be held devoted to the reading of papers, and there will of course be several other sections of the congress, each with a program of papers, as well as addresses before the entire congress on subjects of wide interest by foreign and American entomologists of distinction, all of which will be announced elsewhere in due course.

FORUM ON PROBLEMS OF TAXONOMY

An address on "The Future of Insect Taxonomy" will be given by Dr. Walther Horn, of Berlin. Following this address, the session will be devoted to a discussion of the problems that are in increasing measure confronting the insect taxonomist. It is hoped that all attending will come prepared to make contributions to the discussion and definite constructive suggestions. Perhaps a result of the session may be the formation of permanent committees looking toward improvement of, or international cooperation in regard to some of the problems discussed.

Taxonomic and Phylogenetic Groups: Is the modern tendency toward infinite increase in the taxonomic groups of organisms and the raising of the rank accorded them a result of the narrowing horizon of specialists or is it a sound growth forced by a better understanding of biological processes?

Catalogs: The preparation of world catalogs is becoming almost an economic impossibility. They become rapidly out of date and their revision and republication even less possible. Can means be found to meet the situation?

Collections: How far are insect collections economically justified? How far should they be centralized? To what extent supported by public moneys? How far has the entomological public a

moral interest and rights in private collections which have become the basis of important published work and what steps can be taken looking toward the eventual public ownership of such collections? Could a close cooperation be developed between certain leading collections of each country or at least continent to the end that by an automatic distribution of surplus material with each other, there would eventually be built up one or two central world collections in each major country or continent? How far can the progress of taxonomy be best served by the free loan of material to specialists? Can a uniformity of practice be established concerning division of material thus borrowed between the museum and the specialist?

Types: What progress can be made toward definite fixation of the type specimens of older authors? Is a cooperative undertaking possible looking toward the eventual recording and possibly also joint publication of the location of all type specimens now in existence? How far are special designations for different categories of "types" useful and advisable, and can we come to a uniform practice in their application?

What should be the policy of custodians of types toward their loan and what toward their isolation from generally used collections?

Determinations: Vigorously expanding research in ecology, life histories, morphology, genetics, applied entomology has not been accompanied by a corresponding increase in taxonomists, upon whom these researchers are dependent for determinations. How can this need, which will increase as time goes on, be met?

FORUM ON PROBLEMS OF NOMENCLATURE

There will be an address on "The Future of Zoological Nomenclature," by Dr. Charles W. Stiles, secretary of the International Commission on Zoological Nomenclature. The remainder of the session will be devoted to an informal discussion of nomenclatorial problems, as affecting entomology.

The Theory of Nomenclature: There exist two conflicting points of view. The one is that the principle of priority must be strictly observed in all cases in order to do justice to the taxonomist who first proposed each name. This, therefore, makes its application a matter of moral obligation. The other point of view is that there is no essential principle behind nomenclature, that the sole aim is to secure uniformity of practice, and that while the principle of priority is in the main a useful tool, it should be discarded just at the point where it hampers and impedes more than it assists in securing uniformity and convenience.

Family Names: Is it desirable for this congress to take steps looking toward the adoption of a definite method for determining the type genus of a family, and consequently the family name?

Would it be desirable to establish an international committee to compile information upon the status of all family or subfamily names in order to determine the sense in which they have been most generally used and to recommend to the International Commission on Zoological Nomenclature that their usage be conserved in such sense?

Other problems of nomenclature that any one in attendance may wish to raise.

J. CHESTER BRADLEY,
Secretary, Section on Taxonomy, Distribution and Nomenclature

DOES THE AMOUNT OF FOOD CONSUMED INFLUENCE THE GROWTH OF AN ANIMAL?

THE original article appearing in this journal[1] under the above title solicited the attention of investigators in animal physiology to what appeared to the author to be a serious defect in methods of experimentation being widely used in attacking problems relating to nutrient requirements, the nutritive values of food materials and the synthetic capacities of animal cells. It was an attempt to define the tacit implications upon which these methods are based and to show that they are not sufficiently well established, or, in some cases, even sufficiently plausible, to render any method based upon them an effective instrument of research. It was hoped that the article would stimulate discussion of the fundamental principles of such experimental methods, since these principles have not been critically discussed elsewhere.

W. C. Rose,[2] in an article bearing the same title as this communication, has offered a defense of the methods criticized, specifically a defense of feeding experiments in which the intake of food by otherwise comparable animals or in otherwise comparable experimental periods has not been equalized. This defense was prompted by the fact that some of his work was cited anonymously in my original criticism for purposes of illustration.

In his work on the indispensability of arginine and histidine,[3] Rose is convinced that the inadequate food consumption of rats on the low-histidine rations was the result of dietary inadequacy, and in defense of his conclusion he cites a number of opinions of eminent investigators in nutrition to the effect that animals

[1] Mitchell, H. H., SCIENCE, 1927, lxvi, 596.
[2] Rose, W. C., SCIENCE, 1928, lxvii, 488.
[3] Rose, W. C., and Cox, G. J., *J. Biol. Chem.*, 1924, lxi, 757; 1926, lxviii, 217.

on inadequate diets tend to reduce their food intake. This tendency was specifically recognized in my preceding article, but surely the fact that incomplete or inadequate diets ultimately, or even immediately, lead to a diminution in the intake of food is no justification for the assumption that a diminished or inadequate intake of food is *prima facie* evidence of the incompleteness or the inadequacy of the diet fed. The latter assumption requires also the proof that qualitative inadequacy in the diet is the *only* cause of inadequate food intake, and this proof has not been furnished. The only evidence offered for the inadequacy of the histidine-free diets is the failure to obtain growth with them. But in no case was it shown that these diets were consumed in amounts which would support growth or maintenance if they had been adequate in every respect.

Rose cites the consistency with which his experimental rats ate sparingly of the histidine-free (but arginine-containing) diets as "convincing proof that arginine and histidine are not interchangeable in metabolism . . ." It is true that this uniformity in the reaction of his animals to histidine-free diets contributes to the significance of the conclusion drawn, but after all such evidence is circumstantial in character and can not be entirely convincing.[4] If this position is not acceptable to Rose, the fact that other investigators,[5] working on the same problem with methods identical in all essentials with his own, have also obtained consistent results but of an opposite or a different significance, should lead him to modify the positiveness of his conclusions.

Failures of growth in experimental animals when consuming amounts of food that, regardless of its composition, would be unable to support growth, may fairly be regarded as negative evidence with reference to the nutritive value of the diet. This position is recognized in many published articles containing the results of feeding experiments not involving control of food consumption. In 1924, M. L. Mitchell[6] obtained results on mice indicating in a positive fashion that taurine can replace cystine in animal nutrition. In the following year, Beard[7] published a report of feeding experiments on mice that did not bear out this interpretation. He was, however, content to draw the non-committal conclusion that "the results here obtained do not confirm the conclusion of Mitchell that taurine can replace cystine in the diet of mice." Using similar uncontrolled methods, Lewis and Lewis[8] also obtained negative results relative to this metabolic interchangeability, stating in conclusion simply that "no evidence was obtained which indicated that either taurine or cysteinic acid could replace cystine entirely or in part for purposes of growth." However, on the basis of the same sort of evidence, Rose and Huddlestun[9] conclude that "taurine is totally incapable of replacing cystine in the diet for purposes of growth." This appears to be an exaggeration of the importance of negative evidence.

It is a fundamental requirement of rigorous experimentation that two animals (or periods) which are to be compared should differ in only one factor capable of affecting the thing measured, such as rate of growth. The rate of growth of an animal is undoubtedly affected both by the composition of its diet and by the amount consumed. Therefore, if it is desired to measure the effect of the composition of the diet only, some method of equating the food intake must be devised. If the animals are of the same size, equal food intakes may be imposed; if of different size, equal food intakes per unit of weight. In comparing the value of different proteins for growth, Osborne and Mendel[10] have prescribed the condition that the experimental animals must eat "the same amount of food in the same number of days and gain the same amount of weight, the protein factor being the only variable."

The advantages in clarity of interpretation of equating the food intakes of comparable animals may be illustrated from the article of Lewis and Root[11] on the value of nor-leucine as a substitute for lysine in nutrition. Rat 5 in a seventy-day period consumed an average of 3.87 grams of a ration containing gliadin as the sole source of protein and gained an average of 0.14 gram daily. In a subsequent forty-two-day period it received a lysine supplement to this diet and

[4] On the same basis, Osborne and Mendel (*J. Biol. Chem.*, 1917, xxxii, 369) might have concluded that soybean proteins were inadequate for growth, since in their first experiments the soybean rations were not readily consumed and little growth resulted. It was later found that the rations were consumed in adequate amounts if the soybean meal were previously subjected to heat in the presence of water. Without changing the nutritive value of the ration to any considerable extent, normal growth was now produced with it.

[5] Ackroyd, H., and Hopkins, F. G., *Biochem. J.*, 1916, x, 551; Geiling, E. M. K., *J. Biol. Chem.*, 1917, xxxi, 173; Stewart, C. P., *Biochem. J.*, 1925, xix, 1,101.

[6] Mitchell, M. L., *Australian J. Exp. Biol. and Med. Sci.*, 1924, i, 5.

[7] Beard, H. H., *Amer. J. Physiol*, 1925, lxxv, 658.

[8] Lewis, G. T., and Lewis, H. B., *J. Biol. Chem.*, 1926, lxix, 589.

[9] Rose, W. C., and Huddlestun, B. T., *J. Biol. Chem.*, 1926, lxix, 599.

[10] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1916, xxvi, 1; 1919, xxxvii, 223.

[11] Lewis, H. B., and Root, L. E., *J. Biol. Chem.*, 1920, xliii, 79.

gained 1.29 grams daily on a food intake of 5.81 grams per day. Finally, in a thirty-five-day period in which it received nor-leucine as a supplement, its average daily gain was .07 gram and its daily food consumption 4.94 grams. While it may be quite probable that the increased rate of growth in the second period, as well as the increased food consumption, was due to the fact that lysine, but not nor-leucine, supplemented the gliadin in metabolism, this can not be considered a demonstration until the rates of growth on 5.81 grams (or some equivalent amount) daily of the basal ration and of the basal ration plus nor-leucine have been determined. With Rat 6, the difference in supplementing value of lysine and nor-leucine is more clearly shown, because with lysine an average daily gain of 1.19 grams was secured and with nor-leucine one of only .06 grams on food intakes practically identical, *i.e.,* 5.90 and 5.86 grams daily. In the case of comparing the results on the same animal in successive periods, it is undoubtedly better to equate the food intakes not absolutely, but in proportion to body weight, and, as Lewis and Root observe, such an equating of food intakes in the lysine and nor-leucine periods actually resulted in most cases without deliberate control. As a general plan, however, how much better it would be to assure by deliberate control, rather than to leave to chance, such an essential requisite of effective experimentation!

H. H. MITCHELL

DIVISION OF ANIMAL NUTRITION,
UNIVERSITY OF ILLINOIS

AMOEBA DOFLEINI (NERESHEIMER) VS. MAYORELLA BIGEMMA (SCHAEFFER) A CASE OF SYNONYMY

E. NERESHEIMER (05)[1] described and fully illustrated a rhizopod to which he gave the name Amoeba dofleini. This description agrees in all the essential details with the diagnostic characteristics of a rhizopod described by Schaeffer (18),[2] as a new species under the name of *Amoeba bigemma,* which was afterwards changed by him (26)[3] to Mayorella bigemma.

[1] Neresheimer, E., 1905, "Über vegetative Kernveränderungen bei *Amoeba Dofleini* nov. sp. Arch. fur Protist," Bd. 6, S. 147–165.

[2] Schaeffer, A. A., 1918, "Three New Species of Amebas: *Amoeba bigemma* nov. spec., *Pelomyxa lentissima* nov. spec., and *P. schiedti* nov. spec.," Trans. Am. Mic. Soc., Vol. 37, pp. 1–18.

[3] Schaeffer, A. A., 1926, "Taxonomy of the Amebas," Carneg. Inst. of Washington, Vol. 24, pp. 1–116.

Schaeffer, of course, before publishing his description, made a survey of the literature and for sufficiently good reasons was unable to reconcile the descriptions of Mereschkowsky (79), Parona (83), Fromentel (74) and others with the rhizopods he described, although with respect to Doflein (07), he says, (26), p. 56, "Doflein's figures as to the character of the pseudopods, the size, etc., of the body, agree closely with the amoeba I described, Schaeffer (18), under the name *bigemma.* . . . Consequently I incline to think that Doflein worked with *bigemma.* . . ." Since Schaeffer does not quote Neresheimer I presume he has merely overlooked his work. As stated above Neresheimer published his work in 1905, and, as the name of his animal signifies, it was named after Doflein, with whom Neresheimer worked. Doflein published his investigation on *Amoeba verspertilio* (Penard), the animal Schaeffer thinks is his *bigemma,* in 1907, two years later. This means that Doflein regarded the rhizopod that he worked on as distinct from the one that Neresheimer dealt with, for he must certainly have been familiar with Neresheimer's animals. If this is correct, then it seems that Schaeffer is possibly at error in thinking that his animals are the same as those of Doflein, provided the evidence given below is sufficient.

Neresheimer's description of the outstanding characteristics of Amoeba dofleini follows in roman type and Schaeffer's diagnosis of *Mayorella bigemma* in italics.

Size: 80–150 microns (the larger size more prevalent).
100–300 microns in locomotion.

Form: Assumed wide changeability of form.
Very changeable.

Pseudopods: Broad, short, broken sac-like pseudopods barely extended from the body.
Numerous, tapering, blunt, never with sharp points.

Surface: Without the characteristic ectosarc folds of *A. verucosa.*
Smooth, no fine folds or ridges.

Endoplasm: Contains bar and rarely dumb-bell-shaped crystals from which hang little spheres.
Usually containing numerous small twin crystals: crystals attached to "excretion spheres."

Movement: Lively, brisk.
Rapid, about 125 microns per minute.

Nucleus: A round or oval vesicle, 20 microns in diameter, firm bodies in the form of little masses gathered together around the periphery of the karyosome.
Single, round or slightly oval, about 12 microns in diameter (sometimes as large as 28 microns), chromatin in small masses clumped loosely together in the center of the nucleus in a nearly spherical mass about 6.5 microns in diameter.

Contractile vacuoles: One for the most part occurs, sometimes two or three which flow together before systole.

Small, about 15 microns in diameter; numerous, no coalescence among them; systole slow.

Endoplasm: Permeated with a large number of larger and smaller vacuoles.

Filled with small vacuoles.

Food: Alga filaments, flagellates, nematodes, rotifers and small amoeba.

Flagellates, ciliates, diatoms, rhizopods, nematodes, vegetal tissue, etc.

The only difference of considerable value between the two descriptions lies in Neresheimer's assertion that the contractile vacuoles coalesce before systole, whereas Schaeffer maintains that he has observed vacuoles remain in contact for a minute or more with no coalescence. The descriptions agree so closely that it seems that the two men were describing the same species. This contention is supported by the fact that both Schaeffer and Neresheimer found optically active crystals attached to spheres, and further Schaeffer (18), p. 10, says, "Altogether, the crystals form the most definite specific character of this amoeba, and the presence of such crystals attached to spheres in an amoeba may be regarded as definitely proving its specific identity."

If it is actually true that these authors did describe the same species, as appears to be the case, then according to the recent amendments to the International Rules of Zoological Nomenclature,[4] adopted in 1927, the name of the rhizopod should be *Amoeba dofleini.*

PERCY L. JOHNSON

THE JOHNS HOPKINS UNIVERSITY

DEVONIAN CONCRETIONS OF WESTERN AND CENTRAL NEW YORK

IN studying the stratigraphy of the Devonian, one is impressed with the common occurring concretion.

These peculiar formations, invariably built around a nucleus, may be composed of mud, limestone and even marcasite. The last is of diagenetic origin and is by far the most interesting, from the standpoint of the flora and fauna around which it has formed. As to size, Devonian concretions may range from a few feet in diameter to mere nodules. Their structure usually varies with their composition. Certain upper Devonian concretions possessing the peculiar cone-in-cone structure, for which no explanation has as yet been offered, to the characteristic radial form of marcasite. Again, the larger concretions may be grooved, these cracks being filled with extraneous material, thus giving the appearance of a turtle's shell. Other nodules, as those from the Genundewa limestone, are of even texture, composed entirely of *Styliolina fissurella,* surrounding the nucleus.

To the paleontologist, the flora and fauna that form the basis of most concretions, especially marcasite, offer a fascinating study. In the marcasite nodules, the iron pyrite has replaced the organic, as the case may be, by its silver-white metal. When broken open, the metal quickly tarnishes upon exposure to air, and in a short space of a few weeks will disintegrate. The nuclei can be preserved by immersion in kerosene or by covering with balsam.

The following invertebrate forms have been found in Devonian marcasite: *Phacops rana,* trilobite. Goniatites are quite common, especially *Manticoceras intumescens.* An orthoceras, plus many gastropods and pelecypods, have been found. The latter forms can not very well be identified, owing to the peculiar metallic replacement. As to plant remains, only one specimen has been found in marcasite, probably of the genus *Callixylon.*

The larger mud concretions and "turtle backs" are invariably duds. Though goniatites are frequently found in these freaks of nature, they are not as well defined as their much reduced relative in marcasite.

The type locality for Devonian concretions is the already famous Eighteen Mile Creek, Erie County, New York.

A. EMIL ALEXANDER

CORNELL UNIVERSITY

DIVING EXPERIMENT AT THE UNIVERSITY OF MIAMI

STUDENTS of the general zoology and field zoology classes of the University of Miami were recently introduced to what the writer believes is an entirely new feature in university teaching, when they were given the opportunity to enter the waters of the Atlantic Ocean clad in bathing suits and diving helmets to study the animals living there.

Thirty-three students were taken on the "See-Bottom-Boat," with a movable glass window, making regular trips to the marine gardens beyond Biscayne Bay near Soldier Key, about fifteen miles southeast of Miami. Mr. W. F. Miller, of Miller-Dunn Company, manufacturers of the Miller-Dunn "Divinhood," loaned four helmets for the occasion and following the regular trip over the gardens, the boat was anchored and the students entered the water with the writer in groups of three. The helmet is so easily handled and so simple to operate that thirteen students were enabled to descend to the ocean floor in twenty feet of water and walk about, studying corals, sponges, echinoderms and fishes. No student had used these helmets before and several were unable to

[4] Stiles, C. W., 1928, "Amendments to the International Rules of Zoological Nomenclature," SCIENCE, Vol. 67, pp. 17–18.

swim, but not the slightest difficulty was encountered in carrying out the experiment. With the big copper helmets weighted with lead to hold each diver down and connected to hand pumps on the deck by fifty feet of ordinary garden hose, it was possible to walk around in perfect comfort and pass beneath the boat where those above could plainly see every move through the big glass in the floor of the dark-room.

Sharks and barracuda abound in the waters about the Florida Keys, but they were apparently kept off by the strangeness of the apparitions that constantly bubbled great bubbles of air to the surface as they stalked about among corals, sponges and sea fans.

The writer had used the helmets in 1925 while with Mr. William Beebe among the Galapagos Islands and Cocos Island. While there we found that at a depth of thirty or thirty-five feet, the water rose in the helmet about to the level of the diver's chin, compelling him to keep his head erect. In the shallower depth, chosen for the class experiment, water remained probably two inches lower.

The trip was an experiment, but it proved highly successful and similar ones will take their places as part of the regular schedule of course work in the zoology classes of the university.

JAY F. W. PEARSON

UNIVERSITY OF MIAMI,
CORAL GABLES, FLA.

SCIENTIFIC THEORIES

THERE are indeed grave objections to the use of the word "belief" as a name for the attitude of a scientist toward a proposition, law or theory which he employs in his thinking, experimenting or writing. Dr. E. C. L. Miller's communication in the issue of SCIENCE for March 23 is very pertinent.

His letter suggests to one reader who has given some thought to this matter in recent years such questions as these:

(1) Why should not some of our able popularizers and socializers of science employ their skill to disseminate a knowledge of and an interest in the scientific attitude and method as well as in more transient information in regard to scientific progress? There are opportunities from time to time, as, for instance, when Einstein spoke with such complete detachment of how his theory of special relativity must fall if the Dayton Miller experiments showing ether drift should be confirmed. "Experiment is the supreme court," said he. This might have been dramatized. Fully utilized, his attitude might have done quite as much for the advancement of science as the Miller experiments.

(2) Why should it not become a fixed policy of writers and publishers of text-books in science to see to it that every science book in the future should contain a page or two, at least, intended to make clear to students that there are certain scientific attitudes common to all sciences which are even more important than the specific information constituting a particular science?

(3) Why should not every teacher of science who reads Dr. Miller's letter or this, attempt to formulate for himself and for his students, a little more carefully than he has heretofore, his own conception of the difference between scientific "acceptance for use" on the one hand and "belief" on the other?

In the institution from which I write a considerable number of students have been taught each year recently that real scientists do not believe their theories and laws as other people believe their inherited and absorbed beliefs; that scientists use their generalizations as tools of thought and guides in experimentation and observation; that, in their more rational and more philosophical moments, at least, scientists do no more "believe" their theories, laws, etc., than they believe a benzene ring diagram or a logistic curve. Their generalizations work to correlate and coordinate concepts, observations and experiences with one another. That is enough.

SELDEN SMYSER

WASHINGTON STATE NORMAL SCHOOL,
ELLENSBURG, WASHINGTON

SCIENTIFIC BOOKS

Entomologie d'Haiti. By GEORGE N. WOLCOTT. Republic of Haiti. Published under the direction of the Service Technique du Département de l'Agriculture et de l'Enseignement Professionnel. Port-au-Prince, Haiti, 1927. 440 pp., 133 figs., 8vo, cloth.

THIS volume, which is the second of a series of works written for the use of the students of the Central School of Agriculture of Haiti, is far more than the usual government or state bulletin.

It is necessarily largely a compilation of the facts known to every entomologist, which form the basis of the study of insects, and yet Dr. Wolcott has given his book quite a tropical flavor. The reader will be surprised at the start by the many excellent illustrations, many original and by the author or by M. Fritz Maximilien.

The work begins with a short discussion of entomology as a science and as a branch of zoology. The next chapter is headed "Les Arthropodes," and defines the members of this group and gives much interesting information.

The external anatomy of insects is next taken up, then internal anatomy and then development.

Several chapters are grouped under "Ecologie des Insectes," and treat ecology as a science, insects in their relation to plants, insects in their relation to other animals, interrelations among insects, insects in their relation to environmental conditions, psychology of insects, insects in their relation to man, the war against insects—the latter a discussion of economic poisons.

A number of chapters are grouped under "Ordres des Insectes," and here Dr. Wolcott follows Comstock in a general way, though giving prominence in tropical forms.

The last group of chapters has the heading, "Entomologie pour le Fermier," and after a brief introduction we find discussions of insects which attack sugar cane, coffee, tobacco, fruit, truck crops, stored products; then household insects, parasites of poultry, insects attacking animals, insects attacking man.

The reviewer ventures to think that Dr. Wolcott's book would be of value not only in Haiti but in other French colonies as well. An English translation would, he feels sure, be of use in this and other countries.

Both Dr. Wolcott and the department of agriculture of Haiti, which made the work possible, are to be heartily congratulated.

T. E. HOLLOWAY

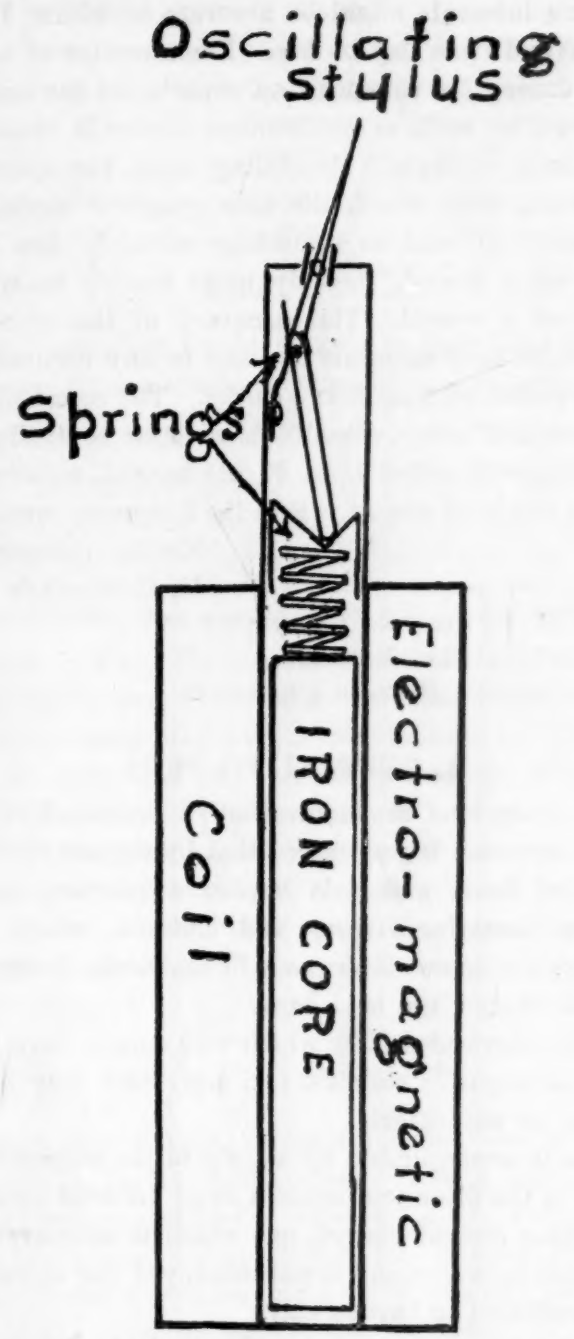
BUREAU OF ENTOMOLOGY,
U. S. DEPARTMENT OF AGRICULTURE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE AND ACCURATE TIME MARKER

THIS time marker takes advantage of the fairly constant frequency of the ordinary alternating current lighting circuit. There are three forms of it that we have considered. The first and simplest consists of a single light reed whose period of vibration is the same as the frequency in the A.C. line. The reed is actuated by a suitable small electromagnet.

The second form of this time marker, which is depicted in Fig. 1, may be looked upon as a modification of the synchronous reed. It consists of a system of levers and a movable soft iron core in an electromagnet. One or more springs, helical or linear, furnish restoring forces. This second form may be designed to be quite powerful. The mechanism which we have modified and used was obtained in the market in the shape of an electric safety razor. It is shown schematically in Fig. 1. These time markers, which may be constructed in the form of a pencil, will require little space and may be readily mounted with any desired freedom of adjustment. It is not easy to construct such a system as that shown in the drawing to have a natural frequency equal to that of the A.C. line. Furthermore, its wave form may not very closely approach a simple sine wave. There are



advantages and disadvantages in having harmonics present in the time graph.

Applying a somewhat different mechanism from the two forms just described for the registration of time intervals of the alternating circuit, we have attempted to employ as the third form of time marker a synchronous motor such as is used in the electric timepiece which is sold under the trade name of Telechron. This apparatus can be made not only to indicate the smallest time interval that may be estimated on the drum, but also, by proper gearing, it can be made to indicate on the graphic record each tenth of a second or other desired interval. It is this form which we hope to set forth in greater detail in the near future.

We would like to emphasize that such synchronous A.C. timing devices are extremely convenient and sufficiently reliable for many ordinary laboratory purposes. In the Cleveland district the potential cycle known as the 60 cycle circuit is constant within a quarter of a cycle from day to day. This means that

the time intervals might be accurate to within 1/240 of a second from day to day. For a matter of a few hours during the course of an experiment the time as indicated by such a synchronous device is considerably more accurate. Depending upon the speed of the drum, upon which the time graph is made, the time may be read to something certainly less than 1/280 of a second, possibly quite readily to within 1/600 of a second. This accuracy of timing refers to relative time intervals and not to any accuracy of synchronism with ordinary clocks. The so-called "60 cycle circuit" may actually have been controlled at any frequency other than 60 per second, as was the case in our local circuit, where the frequency was 59.6.

ENOCH KARRER
H. C. STEVENS

THE H. K. CUSHING LABORATORY OF EXPERIMENTAL MEDICINE,
WESTERN RESERVE UNIVERSITY

BACTERIAL FILTERS

IN a previous communication[1] I described experiments in which it was shown that by the use of filters made of basic materials having a positive electric charge, bacteria, viruses and colloids, which pass through a siliceous filter made of materials of negative electric charge, are held back.

I have devised a filter which will remove both positive and negative colloids, *i.e.*, one which may be described as amphoteric.

This is accomplished by adding to the siliceous material in the filter compound a basic material carrying a positive electric charge, one which is comparatively insoluble in water and is not destroyed nor altered by heat sufficient to harden clay.

Such a material is magnesium oxide calcined at 1300° C. By combining equal parts of this material and Florida kaolin in the filter compound and firing at a temperature not exceeding 900° C. an amphoteric filter is produced.

A temperature higher than this must be avoided, since it will bring about a combination of the magnesia and the siliceous material used and the resulting filter will act as do other siliceous filters.

Filters made as described above will remove both acid and basic colloid dyes.

They will remove bacteria which do not pass a siliceous filter, as well as the so-called filterable bacteria.

The bacterio-phage and the virus of Mosaic disease of tobacco do not pass through these filters.

S. P. KRAMER

CINCINNATI, OHIO

[1] SCIENCE, Vol. LXV, No. 1672, p. 45, Jan. 14, 1927.

SPECIAL ARTICLES

THE OXIDATIVE DESTRUCTION OF THE AGENT OF THE CHICKEN TUMOR I (ROUS)[1]

FROM the time of the first work on the filterable agent of the Chicken Tumor I (Rous), it has been recognized that candle filtrates rapidly lose their infectivity when incubated at 37°. No adequate explanation for this loss appears to have been put forward, although Gye, in his paper of July, 1925, inclined to the view that it might be oxidative. He stated, however, in several lectures given during his recent visit to America, that this auto-inactivation is prevented, or greatly retarded by low concentrations of HCN, and explained this as being due to a poisoning by the HCN of certain proteolytic enzymes which destroy his hypothetical protein "specific factor." The literature, however, contains no evidence that HCN in minute amounts has any effect, except perhaps one of slight acceleration, on tissue proteases. On the other hand, from the work of Warburg and others it is known that certain types of oxidases are inhibited specifically by this reagent.

It occurred to the writer that if the loss on incubation were oxidative, it should be possible to prevent it by some other means than a poison such as HCN, and a number of experiments have been carried out in which cystein in a dilution of 1–2,000 has been added to freshly prepared filtrates of the Rous tumor, and the tubes promptly sealed with vaseline. This has invariably resulted in delaying the loss of infectiousness over control aerobic tubes by many hours. Similarly prepared tubes kept at 4° C. have retained practically their full original potency for several weeks.

One of the annoying features of work with this virus is the great variability in effective strength of different filtrates. Tumors may be produced by one filtrate with 0.001 cc of Mandler filtrate, while on the following day a filtrate made in exactly the same way may fail to infect in a quantity of 1.0 cc. Since there is no method known for determining the properties of such filtrates except to inject chickens and wait two or three weeks, obviously it has always been necessary to set up complex experiments with filtrates of entirely unknown strength, which has led to tremendous waste of time and material. It is hoped that the method of preservation of filtrates with cysteine at low temperatures may find some application in further experimental work with the tumor.

It may also be stated that the initial variation in potency of filtrates is probably due, in part at least,

[1] From the Department of Bacteriology and Immunology, Harvard University Medical School.

to oxidative destruction during the filtration process. In two experiments in which parallel filtrates were made, one in the usual manner, the other with the addition of 1–500 cystein, and protecting as far as possible from the air with liquid paraffin, the latter type of filtrate in each experiment was very much more active than that made in the ordinary way.

It is therefore pretty clear that oxidation will inactivate filtrates of the Rous tumor, although the significance of this fact for a better understanding of the nature of the filterable agent is still not clear. Neill has shown that certain bacterial toxins and enzymes are subject to a reversible oxidation and reduction and it becomes of considerable importance to know whether this "virus" inactivation may be subject to a similar reactivation by means of reducing substances. Up to the present, no clear-cut evidence for this has been obtained, although there have been some indications that it may occur. Should this prove to be the case, the bearing on the interpretation of Gye's complex experiments is obvious.

It is interesting to speculate on how far this property of the filterable chicken tumor agent may be paralleled by other filterable viruses. A number of these, at any rate, exhibit the same phenomenon of rather rapid loss of infectiousness on incubation, and the question is now being studied in this laboratory.

J. HOWARD MUELLER

VELOCITY OF CADMIUM ATOMS REGULARLY REFLECTED FROM A ROCK SALT CRYSTAL

WE have previously shown that a beam of cadmium atoms incident upon a cleavage face of a rock salt crystal is reflected so that the incident and reflected beams make equal angles with the normal to the crystal surface. At that time we suggested that this phenomenon could be interpreted in terms of the phase waves of de Broglie. The existence of a reflected beam making the same angle with the normal as does the incident beam suggests at once the possibility that we have here a situation in which the phase waves behave as X-rays do in the Bragg type of reflection.

We have now measured the velocity and velocity distribution of such reflected beams for three angles of incidence, 22.5°, 45° and 67.5°, using a rotating sectored disc velocity filter in the reflected beam. We find that within the limits of resolution of our apparatus the reflected beam is "monochromatic," *i.e.*, it contains atoms whose velocities are very nearly the same. The velocity of the atoms in the specularly reflected beam is independent of temperature of the reflecting crystal for temperatures from 200° to 500° C.

The results are given in the table:

θ	Velocity observed m./sec.	Velocity calculated m./sec.
22.5°	500	494
45°	530	530
67.5°	600	605

The assumption of de Broglie is that there is associated with a particle of mass M and velocity V a phase wave of wave length $\lambda = \frac{h}{MV}$. We wish now to assume that this equation applies only to the three elementary particles, the photon, electron and proton, and that the wave length associated with an atom whose velocity is V is $\frac{h}{MV}$ where M is the mass of a proton, and not the mass of the atom.

That is to say, we assume that the fundamental periodicity associated with a proton does not change when it combines with other protons to form an atom. We will further assume, following Eckart,[1] that the velocity of phase waves is not the same in a crystal as in free space, so that the form of Bragg law to be used is that used by Davisson and Germer[2] in their work on reflection of electrons by crystals of nickel. That is

$$n\lambda = \frac{nh}{MV} = 2d\ (\mu^2 - \mathrm{Sin}^2\theta)^{\frac{1}{2}}$$

If n were greater than one we would find two or more velocities in the reflected beam. With n equal one we have but one arbitrary constant, μ, the refractive index for phase waves. Using the velocity of the atoms reflected at 45° we find $\mu = 1.50$ and putting this value in the equation we get for the velocities to be expected at 22.5° and 67.5° values of 494 and 605 meters per second, as compared with observed values of five hundred and six hundred meters per second, respectively.

A. ELLETT
H. F. OLSON

STAINING REACTIONS OF FERN GAMETES

THE work of Naylor[1] demonstrated that the retention of stains by fixed and sectioned plant tissues varies with the reaction of the liquids used in washing the slides. The dead cytoplasm of such plants as Naylor used (hyacinth, lupine, etc.), retains basic dyes when washed in buffer solutions alkaline to pH 4.6, but loses them when washed in more acid solu-

[1] Eckart, Proc. Nat. Acad. Sci., 13, 460, 1927.

[2] Davisson and Germer, Proc. Nat. Acad. Sci., 14, 317, 1928.

[1] *Amer. Jour. Bot.*, 13: 265–275, 1926.

tions; acid dyes are retained in solutions more acid than pH 5.0, but lost in solutions alkaline to this point. The material behaves in this respect somewhat like a pure protein, with the difference that its isoelectric "point" (as measured by the retention of dyes) is a range rather than a point; which is taken as indicating that the cytoplasm is a mixture of proteins. With this limitation in mind, we can say that its isoelectric point is from pH 4.6 to pH 5.0. Naylor found that the different parts of the cell had different isoelectric points, that of the chromatin of the resting nucleus being more alkaline (about ph 5.2) than that of the cytoplasm.

Methods similar to those of Naylor have been applied to fern antherozoids (microgametes), with interesting results. The prothallia of *Pteris longifolia* L. were grown in culture. Abundant antherozoids were obtained by mounting prothallia in a drop of distilled water on a slide. They were fixed by inverting the slide over 1 per cent. osmic acid for thirty seconds. After drying, the slides were immersed in stains (1 per cent. aqueous solutions) and afterwards washed in buffer solutions composed of $\frac{M}{200}$ potassium acid phthalate and sodium hydroxide. The buffer solutions varied in hydrogen-ion concentration by intervals or 0.2 pH or 0.3 pH from pH 4.1 to pH 6.0. Since the sodium content has been found to affect the staining, it was held constant by adding suitable amounts of sodium chloride.

The nucelus of the antherozoid retained the acid dyes and lost the basic dyes in buffer solutions acid to pH 4.5 or thereabouts, and detained the basic dyes and lost the acid dyes in more alkaline solutions. Its isoelectric point, as indicated by this method, is therefore in the neighborhood of pH 4.5. That of the cytoplasm, as determined in the same slides, is near pH 5.0. Good differential staining was obtained by the following procedure. The slide was immersed in safranin (a basic dye) for twenty seconds, then destained in a buffer solution of pH 4.1. The cytoplasm lost the stain most readily, since its isoelectric point is more alkaline; the nucleus remained red for some time. Before the nucleus lost its red color the slide was stained in methyl blue (an acid dye for one minute, and then washed in a buffer solution of pH 5.2. This reaction caused the nucleus to lose the blue dye, while the cytoplasm retained it. The slide was then allowed to dry, and sealed in the usual manner. The cytoplasm was stained blue, the nucleus red. Steil's method[2] for differential staining of fern antherozoids also involves the use of an acid and a basic dye (acid fuchsin and safranin), though it includes no control of the reaction of the liquids used in washing. His method also was used by the present writers. The cytoplasm was stained faintly bluish-pink by the acid fuchsin, the nucleus bright red by the safranin.

The chief interest in these results lies in the fact that the nucleus has evidently a more acid isoelectric point than the cytoplasm, and hence behaves like an acid at reactions near pH 5.0, while at the same reaction the cytoplasm may act like a neutral or even alkaline substance. The cytoplasm of the vegetative cells studied by Naylor approximates the cytoplasm of the fern antherozoid in its isoelectric point; but the chromatin of the former cells has a more alkaline isoelectric point (though perhaps somewhat less so during mitosis). It remains, of course, to study by the same methods the vegetative cells and the megagametes (eggs) of the fern. If it is true that the antherozoid nucleus (and the antherozoid is largely nucleus) is more acid at ordinary reactions than its cytoplasm and more acid than either nuclei or cytoplasm of other cells, it may be possible to correlate this property with the physiology of fertilization. Well-known experiments[3] on both plants and animals have shown that the function of the microgamete in initiating development of the megagamete may be simulated by the addition of an organic acid.

The structure of the antherozoid observed in these experiments was that usually described. The nucleus, long, narrow and spirally coiled, occupies most of the cell; the cytoplasm forms a thin envelope around the nucleus and a projecting anterior portion. The blepharoplast, lying along one margin of the cytoplasm, retains the same dyes as does the cytoplasm at each reaction but in greater amounts. The numerous cilia arise from the anterior portion of this body. In many slides the nucleus seemed not homogeneous but composed of small granules; sometimes these gave it a beaded appearance. It is not known whether this appearance is normal or due to the age or death of the antherozoid. Probably the nucleus consists of densely aggregated chromatin in a condition similar to that of the microgamete nuclei of Bryophytes and some Spermatophytes during fertilization. This condition is usually regarded as being comparable to that of the chromatin in the prophases of mitosis; though in ferns, the zygote nucleus, when first formed, is in the resting condition.

J. R. JACKSON
H. W. RICKETT

DEPARTMENT OF BOTANY,
UNIVERSITY OF MISSOURI

[2] *Bot. Gaz.*, 65: 562–563, 1918.

[3] Lillie, F. R., "Problems of Fertilization," Univ. of Chicago, 1919.